

Taxonomic Studies on *Glycine* of Taiwan

Yoichi TATEISHI and Hiroyoshi OHASHI

Biological Institute, Faculty of Science, Tohoku University
Aoba-ku, Sendai, 980 JAPAN

台湾産ダイズ属の分類

立石庸一, 大橋広好

東北大学理学部生物学教室 980 仙台市青葉区荒巻字青葉

(Received on January 18, 1992)

Four species of *Glycine* are recognized in Taiwan: *Glycine dolichocarpa* Tateishi et Ohashi, *G. tomentella* Hayata, *G. tabacina* (Labill.) Benth., and *G. max* (L.) Merr. of which the last one is represented by a wild race. A new combination, *G. max* subsp. *formosana* (Hosokawa) Tateishi et Ohashi, is proposed for the race. A key to these taxa and a description for each of them are prepared.

Introduction

Taxonomic history shows that no species of *Glycine* are keeping the same name when they were recognized for the first time in Taiwan. This fact suggests a complicated history of taxonomy as well as a difficulty of circumscription of species of *Glycine* in Taiwan. During our studies on the Leguminosae of Taiwan (Ohashi et al. 1984, 1991) we have noted difficulties to classify some species of *Glycine*. Recent results on differentiation in *Glycine* by Putievsky and Broué (1979), Newell and Hymowitz (1978, 1980), M.J. Doyle and Brown (1985), J.J. Doyle and Brown (1989), Doyle et al. (1990a, 1990b, 1990c) need intensive studies on morphological distinctions between the species of *Glycine*. Tindale (1984, 1987a, 1987b) and Tindale and Craven (1988) have contributed in Australia which is the center of distribution of the subgenus *Glycine*, one of the two subgenera of the genus,

by describing several new species and by clarifying circumscription of variable species. Taiwan may be the other place to be intensively studied on morphological differentiation of *Glycine*, where plants of both subgenera are growing in wild. We have, therefore, worked for *Glycine* of Taiwan in order to clearly circumscribe every species in wild by morphological characters.

Historical review of taxonomic treatments of Taiwanese *Glycine*

The first record of *Glycine* from Taiwan was made by Forbes and Hemsley (1887), who determined a specimen, Oldham 196, collected at Tamsui in northern Taiwan as *G. tomentosa* (Benth.) Benth. The species was described by Bentham (1838) as *Leptolobium tomentosum* Benth. on the basis of material from Australia. The second Taiwanese *Glycine* was reported by Henry

(1896). Based on a specimen, Henry 1180, collected at Takow, he listed *G. tabacina* (Labill.) Benth. as a native species in southern Taiwan. This species was originally described also from Australia.

Then three new species were recorded by Hayata (1920). The third, *Glycine pescadrensis* Hayata, was collected from Penghu Islands of western Taiwan and *G. tomentella* Hayata from southern Taiwan. The fifth one is *G. subonensis* Hayata from southern Taiwan, but this has been regarded as a species of *Teramnus*. The sixth *Glycine* was recorded by Hosokawa in 1932, who described *G. formosana* Hosokawa from northern Taiwan.

Hosokawa (1935) clarified that *G. pescadrensis* Hayata is identical with *G. clandestina* Wendl. that was described from Australia. Hermann (1962) found that *G. tomentella* Hayata (1920) is identical with *G. tomentosa* (Benth.) Benth. (1864). In *Glycine*, however, the specific epithet *tomentosa* cannot be used because of the presence of earlier homonym, *G. tomentosa* Linnaeus, Sp. Pl. 754 (1753). He adopted the later synonym, *G. tomentella*. Hermann regarded that *G. formosana* is a form of *G. ussuriensis* Regel et Maack having abnormally narrow leaflets and treated the former as a synonym of the latter. Huang and Ohashi (1977) used the name *G. soja* Sieb. et Zucc. instead of *G. ussuriensis*. Newell and Hymowitz (1980) clarified morphological differences between *G. tabacina* and *G. tomentella* and regarded that *G. clandestina* is restricted to Australia. According to them, *G. clandestina* known in Taiwan should be *G. tabacina*.

Tateishi and Ohashi (1991) segregated a distinct form from *G. tomentella* and described it as a new species, *Glycine dolichocarpa* Tateishi et Ohashi. This is the seventh species of *Glycine* from Taiwan and it has been referred erroneously as *G. tabacina* or *G. tomentosa*.

Results of our studies on the historical change of the previous treatments on the species of *Glycine* of Taiwan are summarized in Table 1.

Materials and methods

Field works and collectings of materials for studies on *Glycine* have been done in Taiwan in 1982 and 1988. Detailed data on our collection of *Glycine* have been recorded in our reports (Ohashi et al. 1984, 1991). Living materials have been cultivated in the greenhouse of the Biological Institute of Tohoku University in Sendai. Herbarium specimens have been examined in KYO, TAI, TAIF, TI and TUS.

Key to the taxa

1. Perennial. Racemes longer than petiole. Flowers longer than 6 mm 2.
2. Plants sparsely clothed with appressed short hairs. Calyx-lobes shorter than tube, the upper two lobes united up to below the apices 3) *G. tabacina*
2. Plants densely pubescent. Calyx lobes longer than tube, the upper two lobes united to 2/3 or less. Legumes clothed with spreading long hairs 3.
3. Hairs on stems and petioles deflexed. Leaflets lanceolate to ovate. Flowers 7–8 mm long; upper two calyx-lobes united up to 2/3. Legumes (15–) 22–32(–35) mm long, with (3–)5–9 seeds, not constricted along the suture 1) *G. dolichocarpa*
3. Hairs on stems and petioles rather spreading. Leaflets oblong to elliptic or obovate. Flowers 6–7 mm long; upper two calyx-lobes united to 1/2. Legumes (10–)12–20(–22) mm long, with (1–) 2–5 seeds, constricted between the seeds along the suture...2. *G. tomentella*

Table 1. Historical review of the taxonomy of wild species of *Glycine* in Taiwan

Author		Species			
Forbes and Hemsley	1887	<i>tomentosa</i>	—	—	—
Henry	1896	<i>tabacina</i> <i>tomentosa</i>	—	—	—
Matsumura	1899	—	—	—	<i>tomentosa</i>
Matsumura and Hayata	1906	<i>tabacina</i>	—	—	<i>tomentosa</i>
Kawakami	1910	<i>tabacina</i>	—	—	<i>tomentosa</i>
Hayata	1911	<i>tabacina</i>	—	—	<i>tomentosa</i>
Hayata	1917	—	<i>tabacina</i>	—	<i>tomentosa</i>
Hayata	1920	<i>tomentella</i>	<i>tabacina</i>	<i>pescadrensis</i>	<i>tabacina</i>
Makino and Nemoto	1925	<i>tomentella</i>	<i>tabacina</i>	<i>pescadrensis</i>	<i>tabacina</i>
Sasaki	1928	<i>tomentella</i>	—	<i>pescadrensis</i>	<i>tomentosa</i>
Sasaki	1930	<i>tomentella</i>	<i>tabacina</i>	<i>pescadrensis</i>	—
Makino and Nemoto	1931	<i>tomentella</i>	<i>tabacina</i>	<i>pescadrensis</i>	<i>tabacina</i>
Hosokawa	1935	—	—	<i>clandestina</i>	—
Hosokawa	1936	<i>tomentella</i>	<i>tabacina</i> <i>tomentosa</i>	<i>clandestina</i>	<i>formosana</i>
Hermann	1962	<i>tomentella</i>	—	<i>clandestina</i> (?)	<i>ussuriensis</i>
Chuang and Huang	1966	<i>tomentella</i>	<i>tomentosa</i>	<i>tabacina</i>	<i>ussuriensis</i>
Huang and Ohashi	1977	<i>tomentella</i>	<i>tomentella</i>	<i>clandestina</i>	<i>soja</i>
Huang and Huang	1987	<i>tomentella</i>	<i>tomentella</i>	<i>tabacina</i>	<i>max</i> ssp. <i>soja</i>
Present study		<i>tomentella</i>	<i>dolichocarpa</i>	<i>tabacina</i>	<i>max</i> ssp. <i>formosana</i>
Distribution in Taiwan		SW. coast, S. part and (N. coast)	SE. and N. coast	W. part (Isls. Penghu)	N. part, and Central Mts.

—: not treated by the author.

- | | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. Annual. Racemes quite shorter than petiole.
Flowers 5–6 mm long 4) <i>G. max</i></p> <p>5. Erect herb. Leaflets lanceolate to ovate.
Legumes larger, 30–70 × 10 mm. Seeds
large, longer than 6 mm. Cultivated</p> | <p>..... subsp. <i>max</i></p> <p>5. Twining herb. Leaflets subulate to
lanceolate. Legumes smaller, 9–22 × 3.5–5
mm. Seeds small, 2.3–4 mm long
..... subsp. <i>formosana</i></p> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Taxonomic treatments

1) *Glycine dolichocarpa* Tateishi et Ohashi in Sci. Rep. Tohoku Univ. 4th ser. (Biol.) **40**: 23, fig. 5 (1991).

Glycine tomentosa auct. non L. (1753) nec (Benth.) Benth. (1864); Hosokawa in Masamune, Short Fl. Formosa 100 (1936). Chuang and Huang, Leg. Taiwan Pasture 56, pl. 79 (1966).

Glycine tabacina auct. non (Labill.) Benth. (1864); Hayata, Icon. Pl. Formos. **6** (suppl.): 20 (1917); **9**: 29 (1920), p.p. Sasaki, List Pl. Formosa 233 (1928); Cat. Govern. Herb. 276 (1930). Hosokawa, l. c. 100 (1936).

Glycine tomentella auct. non Hayata (1920): Huang and Ohashi in Fl. Taiwan **3**: 298, pl. 595 (1977), p.p. Huang and Huang in Taiwaniana **32**: 64 (1987), p.p.

Japanese name: ナガミツルマメ (nov.).

A twining or prostrate herb. Stems sinistrally twining, terete, 0.8–1.5 mm in diameter, densely clothed with deflexed long towny hairs (up to 1 mm long). Leaves pinnately trifoliolate. Stipules narrowly triangular, 3–4 mm long, striate, densely clothed with spreading long towny hairs. Petioles 2–4.5 cm long, densely clothed with deflexed long towny hairs (up to 1 mm long); pulvini 1.5–3 mm long, hairy as in the petiole; terminal petiolule 2–4 mm long, densely clothed with deflexed or spreading long towny hairs; stipels linear, subulate, 1.5–2 mm long, densely clothed with spreading hairs; secondary pulvini 1.5–2 mm long, hairy as in the terminal petiolule. Leaflets chartaceous, clothed with ascendent or rather appressed long hairs (up to 1 mm long) on both sides, veins not prominent due to the vestiture. Terminal leaflet lanceolate to narrowly ovate (1:4–2:5), 3–6 cm long, 1.2–2 cm wide, obtuse or acute and mucronulate at the apex, obtuse at the base. Lateral leaflets slightly inaequilateral, lanceolate to narrowly ovate (1:4–2:5), 1.5–5 cm

long, 0.5–2 cm wide, the apex and the base as in the terminal leaflet.

Racemes axillary, 2 (or more) times as long as the petioles, with 5–13 chasmogamous flowers (mostly crowded towards the apex); rhachis 1–4.5 cm long, densely clothed with deflexed long towny hairs (up to 1 mm long); peduncle 1–6 cm long, pubescent as the rhachis. Bracts longer than the pedicel, 1.5–2 mm long, subulate to lanceolate, densely pilose. Chasmogamous flowers (Fig. 1A) 7–8 mm long. Pedicels about 1 mm long, clothed with deflexed hairs. Bracteoles 1.5–2 mm long, subulate, densely pilose. Calyx campanulate, densely clothed with rather spreading or ascending long hairs (up to 0.7 mm long) outside, glabrous inside, 3.5–4.5 mm long; tube 2–2.5 mm long; upper two lobes united to about two third, 2–2.5 mm long; lateral lobes lanceolate to narrowly triangular, 1.5–2 mm long; lower lobe lanceolate to narrowly triangular, about 2 mm long. Corolla pink. Standard pinkish, with a white or greenish patch near the center inside, 8–8.5 mm long including 1.5–2 mm long claw, the lamina orbicular or transversely broadly elliptic, 7.5–8 mm wide, emarginate at the apex. Wings pink, 7–8 mm long including 2.5–3 mm long claw, the laminae 2.5–3 mm wide, narrowly obovate, more or less constricted at the middle. Keel-petals pink in upper part, distinctly shorter than the wings, 5.5–6 mm long including about 3 mm long claw, the laminae about 2 mm wide, elliptic, adnate each other along their lower margin. Stamens diadelphous, filaments of 9 stamens joined into a column, vexillary stamen sometimes adnate partly to the column. Ovary sessile, linear, pubescent with long appressed hairs, 3–3.5 mm long, (4–)5–9-ovuled; style glabrous; stigma terminal, capitate.

Cleistogamous flowers (Fig. 1A: cl and cl') solitary or in few-flowered fascicles at the axils; calyx narrowly campanulate, 2–3 mm long, the

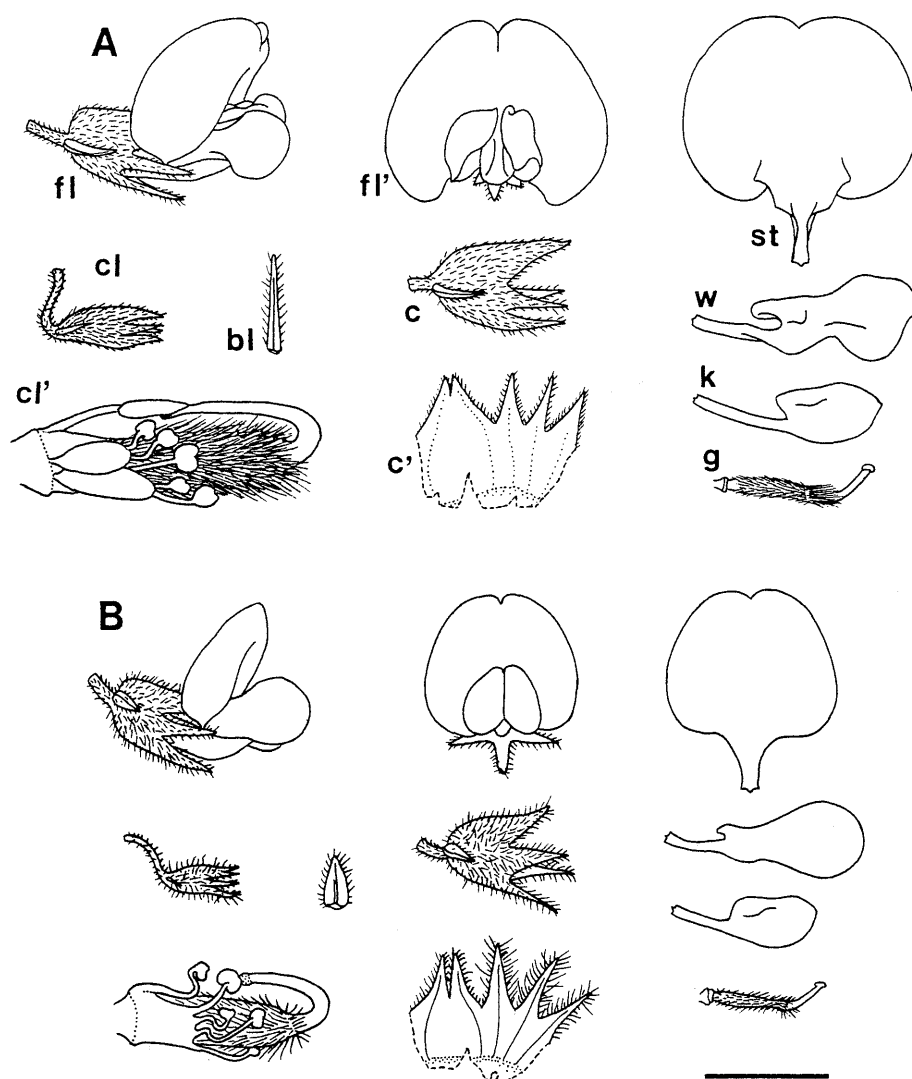


Fig. 1. Flowers of *Glycine dolichocarpa* (A) and *G. tomentella* (B). fl: Flower. fl': Flower in front view. bl: bracteole. c: Calyx. c': Calyx dissected showing inside. st: Standard. w: Wing. k: Keel-petal. g: Pistil. cl: Cleistogamous flower. cl': Cleistogamous flower dissected showing recurved pistil and undeveloped petals and stamens. A from Taiwan, Taitung (Tateishi et al. 25349, TSU-holotype). B from Taiwan, Pingtung (Tateishi et al. 25220, TUS). Scale bar indicates 1 mm for cl', 2 mm for bl, and 4 mm for the others.

tube slender, the lobes almost as long as the tube.

Legumes (Fig. 2) linear, flattened, straight, not constricted between the seeds, brown when matured, densely to sparsely clothed with short or long deflexed hairs, dehiscing spirally into two valves. Chasmogamous legumes (20–)25–32 (–35) mm long, 3.5–4 mm wide, with (4–)5–9

seeds. Cleistogamous legumes (15–)22–30(–32) mm long, 3–3.5 mm wide, 5–9-seeded. Seeds dark brown or black, quadrate or ellipsoidal, 2.2–2.5 mm long, 1.8–2.3 mm wide, 1.2–1.6 mm thick; membrane covering over the seeds reticulate with scattered large tubercles; hilum elliptic, the aril rather thick, the hilar tongue large, flap-like,

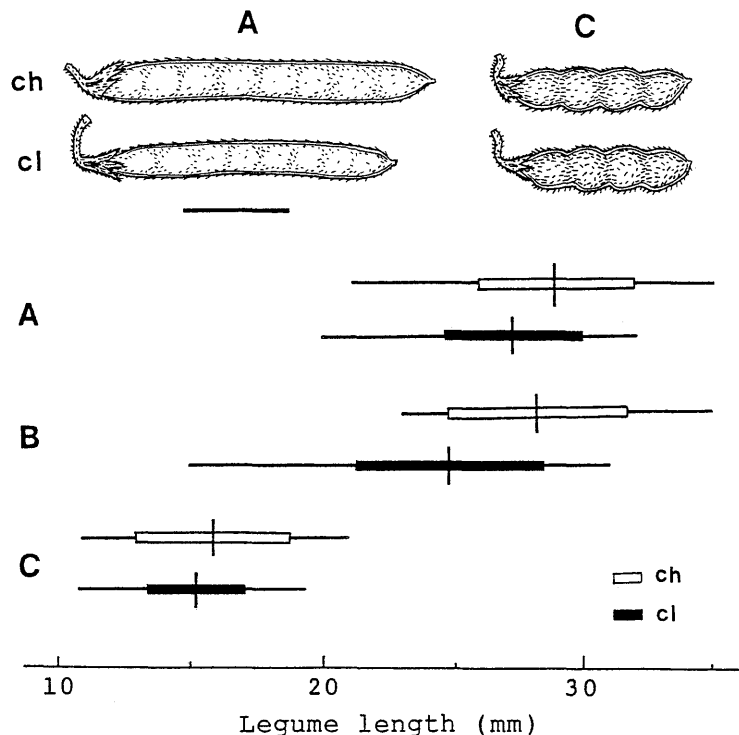


Fig. 2. Legumes of *Glycine dolichocarpa* (A, B) and *G. tomentella* (C). A from Taiwan, Taitung (Tateishi et al. 25349, TUS—holotype). B from Taiwan, Taitung (Tateishi et al. 25387, TUS). C from Taiwan, Pingtung (Tateishi et al. 25220, TUS). ch: Chasmogamous legume. cl: Cleistogamous legume. Scale bar for legumes A and C indicates 1 cm. Thin lines, thick lines and bars show ranges, SDs, and means, respectively. See Table 2 for numbers of the legumes measured and detail data.

overhanging the hilum.

Specimens examined. TAIWAN. TAIPEI: Taipei (S. Sasaki, 2 Oct. 1934, fr. TAI).

TAOYUAN: Hsinwu beach, alt. 3 m (Shimada 1530a, 7 Jun. 1928, fl. and fr. TAI).

TAITUNG: Tungho, seaside (Tateishi, Nemoto and Hoshi 25349, 5 Nov. 1988, fl. and fr. TUS—Holotype; TUS, TAI, TI and A—Isotypes), (S.F. Huang 1703, 22 Jun. 1984, fl. and fr. TAI, TUS); Peinan (Kawakami and Kobayashi 1566, 20 Jun. 1906, fl. TAIF, TI), (K. Kobayashi, 4 Jul. 1906, fl. TAIF), (M.T. Kao 3546, 23 Jul. 1959, fl. and fr. TAI), Peinan, along Peinan-hsi River, alt. ca. 10 m (Tateishi, Nemoto and Hoshi 25387, 6 Nov. 1988, fr. TUS). Shihshan, alt. ca. 100 m (Tateishi,

Nemoto and Hoshi 25407, 6 Nov. 1988, fr. TUS). Saruha (S. Suzuki 5543, 17 Oct. 1934, fl. and fr. TAI). Chengkung [Seikoo] (E. Matuda T499, 18 Aug. 1918, fl. TI). Turan (E. Matuda T510, 8 Aug. 1918, fl. and fr. TAI, TI).

Distribution: Southeast coast and northern part of Taiwan (Fig. 3).

Habitat: In sunny places of wastelands or roadsides near the sea.

Plants referable to *Glycine dolichocarpa* were reported for the first time by Hayata (1917) as *G. tabacina*, when he recorded the first *Glycine* plant from southeastern Taiwan. His report is supposed to be based on a specimen collected by Kawakami and Kobayashi (no. 1566, TAIF, TI) on June 1906

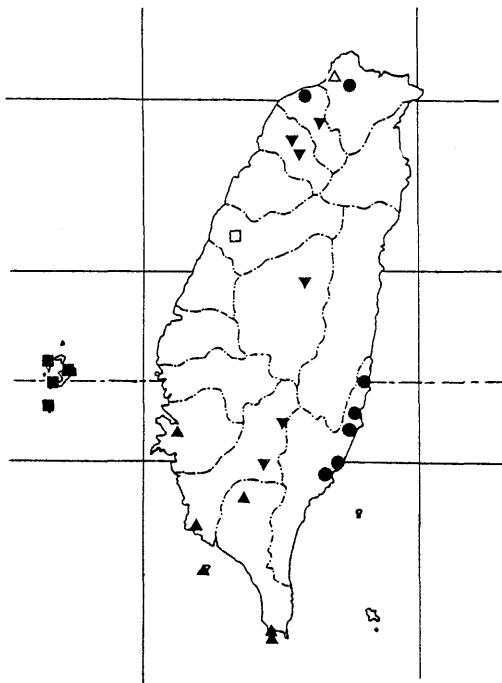


Fig. 3. Distribution of *Glycine* species in Taiwan. ●: *G. dolichocarpa*. ■: *G. tabacina* (□: only by record). ▲: *G. tomentella* (△: only by record). ▼: *G. max* subsp. *formosana*.

at Peinan in southeastern Taiwan. This is the oldest collection of *G. dolichocarpa*. The name *G. tabacina* had been used for *Glycine* plants found in southern Taiwan since Henry (1896). However, Hayata (1920) distinguished the southern plants from the southeastern ones and named it as *G. tomentella*. Hosokawa (1936) recognized *G. tabacina* and *G. tomentosa* for the southeastern *Glycine*. Chuang and Huang (1966) illustrated the southeastern plants under the name *G. tomentosa* Benth. Huang and Ohashi (1977) and Huang and Huang (1987) united these southeastern and southern *Glycine* plants and treated them under the name *G. tomentella*.

Glycine dolichocarpa is most similar to *G. tomentella*, but is distinguished from it by legume characters in combination with differences in flower, calyx, leaflet, and hairiness in stems and

petioles between them.

Legumes and seeds of *G. dolichocarpa* and *G. tomentella* were examined in many specimens of our collection in Taiwan (Fig. 2; Tab. 2). The legumes of *G. dolichocarpa* are usually 22–32 mm long. The chasmogamous legumes are usually somewhat larger than the cleistogamous ones, i. e. (20–)25–32(–35) mm long and 3.5–4 mm wide in the chasmogamous legumes against (15–) 22–30(–32) mm long and 3–3.5 mm wide in the cleistogamous ones. Both types of legumes are not constricted along their sutures between seeds (Fig. 2). On the other hand, the legumes of *G. tomentella* are (10–)13–20(–22) mm long and both chasmogamous and cleistogamous legumes are almost same in length. The legumes of *G. tomentella* are constricted along their sutures between seeds (Fig. 2). Numbers of seeds differ in relation to the difference in these legume length between both species. *Glycine dolichocarpa* has (3–)5–9 seeds, while *G. tomentella* has (1–)2–5 seeds (Fig. 2; Tab. 2).

Terminal leaflets of *G. dolichocarpa* are lanceolate to ovate, while those of *G. tomentella* are oblong to elliptic or obovate. Flowers of *G. dolichocarpa* and *G. tomentella* were compared in detail (Fig. 1). Those of *G. dolichocarpa* are 7–8 mm long and apparently larger than those of *G. tomentella* whose are 6–7 mm long. Upper lobes of the calyx are united up to 2/3 from the base in *G. dolichocarpa*, while those are united up to 1/2 in *G. tomentella*. These differences are summarized in Table 3.

G. tabacina is the next similar species to *G. dolichocarpa*. The former species is, however, differs from the latter having sparsely pubescent stems and leaves with appressed hairs and calyxlobes, of which the upper two are connate up to below the apices, longer than the tube.

Table 2. Variations of legume length and seed number in *Glycine dolichocarpa* and *G. tomentella*

Acc. no*	Type** & no	Seed/legume mean \pm SD	Percent and length (mean \pm SD mm) of legumes with							
			2 seeds		3 seeds		4 seeds		5 seeds	
<i>G. dolichocarpa</i>										
25349	CH 58	7.3 \pm 1.0	0	—	0	—	1.7	23.0 \pm 0	3.4	21.5 \pm 0.5
	CL 47	7.0 \pm 0.9	0	—	0	—	0	—	8.5	22.8 \pm 1.5
25387	CH 14	6.9 \pm 1.2	0	—	0	—	0	—	21.4	23.7 \pm 0.9
	CL 32	5.9 \pm 1.2	0	—	0	—	6.3	15.5 \pm 0.5	40.6	23.3 \pm 1.5
<i>G. tomentella</i>										
25220	CH 24	3.4 \pm 1.0	20.8	12.0 \pm 0.9	33.3	15.0 \pm 1.8	25.0	17.3 \pm 1.3	20.8	19.6 \pm 1.0
	CL 49	3.8 \pm 0.6	2.0	12.5 \pm 0	24.4	13.3 \pm 1.2	63.2	15.5 \pm 1.2	10.2	18.8 \pm 0.5

* 25349 from Taitung: Tungho (Tateishi et al. 25349); 25387 from Taitung: Peinan (Tateishi et al. 25387); 25220 from Pingtung, Maopitou (Tateishi et al. 25220). The voucher specimens of all the materials are preserved in TUS. See the specimens citation for their details.

** Type of the legume, i.e. CH: Chasmogamous; CL: Cleistogamous.

Percent and length (mean \pm SD mm) of legumes with								Total	
6 seeds		7 seeds		8 seeds		9 seeds		mean \pm SD (mm)	range (mm)
13.8	26.3 \pm 1.4	32.8	27.8 \pm 1.7	41.4	31.1 \pm 1.1	6.9	33.0 \pm 1.2	29.0 \pm 3.0	21.0–35.0
17.0	24.7 \pm 2.1	48.9	27.5 \pm 1.3	21.3	29.9 \pm 1.4	4.3	31.0 \pm 0	27.3 \pm 2.7	20.0–32.0
14.3	26.5 \pm 1.5	28.6	28.8 \pm 2.5	28.6	30.5 \pm 1.1	7.1	35.0 \pm 0	28.3 \pm 3.5	23.0–35.0
21.9	25.1 \pm 1.1	18.8	27.8 \pm 1.2	12.5	30.3 \pm 0.4	0	—	24.9 \pm 3.6	15.0–31.0
0	—	0	—	0	—	0	—	15.9 \pm 3.0	11.0–21.0
0	—	0	—	0	—	0	—	15.3 \pm 1.9	11.0–19.5

Table 3. Differences between *Glycine dolichocarpa* and *G. tomentella*

Character	<i>G. dolichocarpa</i>	<i>G. tomentella</i>
Leaflets	lanceolate to ovate	oblong to elliptic or obovate
Indumentum	dense deflexed long hairs	dense rather spreading long hairs
Flower length	7–8 mm	6–7 mm
Upper calyx-lobes	united to 2/3	united to 1/2
Legumes	not constricted	constricted
length	(15–)22–32(–35) mm	(10–)12–20(–22) mm
seed number	(3–)5–9	(1–)2–5

2) *Glycine tomentella* Hayata, Icon. Pl. Formos. 9: 29 (1920). Sasaki, List Pl. Formosa 233 (1928); Cat. Govern. Herb. Formosa 276 (1930). Hosokawa in Masamune, Short Fl. Formosa 100 (1936). Hermann in U.S. Dept. Agric., Techn. Bull. no. 1268: 23, fig. 6 (1962); Chuang and Huang, Leg. Taiwan Pasture 56 (1966). Huang and Ohashi, Fl. Taiwan 3: 298 (1977). Newell and Hymowitz in Brittonia 32: 63 (1980). Huang and Huang in Taiwan 32: 64 (1987). Ohashi et al. in Sci. Rep. Tohoku Univ. 4th ser. (Biol.) 40: 26 (1991).

Leptolobium tomentosum Benth. in Ann. Wien Mus. 2: 125 (1838).

Leptocyanus tomentosus Benth. in Linn. Soc. Lond. Trans. Bot. 18: 209 (1839).

Glycine tomentosa (Benth.) Benth., Fl. Austral. 2: 245 (1864), non L. (1753); Forbes and Hemsley in J. Linn. Soc. Bot. 23: 189 (1887). Henry, List 34 (1896).

Glycine tabacina auct. non (Labill.) Benth. (1864); Henry, List 34 (1896). Matsumura and Hayata, Enum. Pl. Formos. 109 (1906). Kawakami, List Pl. Formosa 29 (1910). Hayata, Icon. Pl. Formos. 1: 196 (1911).

Chinese name: 潤葉大豆. Japanese name: ヒロハヤブマメ (Sasaki 1928).

A twining or prostrate perennial herb. Stems terete, 0.3–1.3 mm in diameter, densely clothed with spreading brownish hairs (0.3–1 mm long). Leaves pinnately trifoliolate. Stipules triangular-ovate, 1–2 mm long, striate, densely clothed with spreading long hairs. Petioles 5–50 mm long, densely clothed with spreading long brownish hairs (up to 1 mm long); pulvini 1.5–3 mm long, hairy as in the petiole. Terminal petiolule 2–5 mm long, densely clothed with spreading long brownish hairs; stipels linear to lanceolate, 1–1.5 mm long, densely clothed with spreading hairs; secondary pulvini 1–1.5 mm long, hairy as in the petiolule.

Leaflets chartaceous, densely clothed with rather spreading hairs (0.3–1 mm long) on both sides, veins prominent below. Terminal leaflet oblong to elliptic or obovate (1:3–3:5), 1.5–4.5 cm long, 0.8–2.5 cm wide, obtuse or rounded and more or less mucronulate at the apex, obtuse at the base. Lateral leaflets slightly inaequilateral, oblong to elliptic (1:2–2:3), 1–3 cm long, 0.5–2 cm wide, the apex as in the terminal leaflet, obtuse or rounded at the base.

Racemes axillary, usually 2 times as long as the petioles or more, with 6–15 chasmogamous flowers (mostly crowded towards the apex); rachis 1–5 cm long, densely clothed with retrorsely spreading or spreading long yellowish hairs (0.3–1 mm long); peduncle 1–7 cm long, pubescent as the rachis. Bracts shorter than or as long as the pedicel, 1–2 mm long, lanceolate to narrowly ovate, densely pilose, caducous. Chasmogamous flowers (Fig. 1B) 6–7 mm long. Pedicels 1–2 mm long, densely clothed with deflexed hairs. Bracteoles 1–1.5 mm long, subulate to lanceolate, densely pilose. Calyx campanulate, densely clothed with spreading long hairs (up to 0.7 mm long) outside, glabrous inside, 4–5 mm long; tube 2–2.5 mm long; upper two lobes united to about the middle, 2–2.5 mm long; lateral lobes subulate to lanceolate, 2–2.5 mm long; lower lobe subulate to lanceolate, 2–2.5 mm long. Standard pinkish, with a white patch near the center inside, 6.5–7 mm long including 1.5–2 mm long claw, 5.5–6 mm wide, the lamina ovate to broadly ovate, emarginate at the apex. Wings reddish purple in the upper half, 6–6.5 mm long including 1.5–2 mm long claw, 2–2.5 mm wide, the laminae narrowly obovate. Keel-petals dark reddish purple in upper part, distinctly shorter than the wings, 4.5–5 mm long including about 2 mm long claw, about 1.5 mm wide, the laminae elliptic, adnate each other along their lower margin.

Stamens diadelphous, filaments of 9 stamens joined into a column, vexillary stamen sometimes adnate partly to the column. Ovary subsessile, linear, sparsely to densely clothed with long appressed hairs, 2–3 mm long, (1–)2–5-ovuled; style glabrous; stigma terminal, capitate.

Cleistogamous flowers (Fig. 1B: cl. and cl') solitary or in several-flowered fascicles at the axils; calyx narrowly campanulate, 2.5–3 mm long, densely clothed with long spreading hairs, the tube slender, the lobes almost as long as the tube.

Legumes (Fig. 2) linear, flattened, straight, more or less constricted between the seeds, brown when matured, densely clothed with long spreading hairs, dehiscing spirally into two valves. Chasmogamous legumes (10–)12–20(–22) mm long, 3–3.5 mm wide, (1–)2–5-seeded. Cleistogamous legumes 12–20 mm long, 3–3.5 mm wide, with (1–)2–5 seeds. Seeds dark brown or black, quadrate or ellipsoidal, 2.2–2.5 mm long, 1.8–2.5 mm wide, 1.2–1.6 mm thick; inner layers of endocarp remaining and covering over the seed coat, thin, reticulate with scattered large obscure tubercles; hilum elliptic, the aril rather thick, the hilar tongue large, flap-like, overhanging the hilum.

Specimens examined. TAIWAN. TAINAN: No precise locality (T. Soma, s.n. in 1915, fl. and fr. TI–**Lectotype** designated), (T. Soma, Sep. 1913, fl. TI–Syntype), (Y. Shimada, 3 May 1915, fr. TI–Syntype), (Takaki, May 1915, fl. TAIF).

KAOHSIUNG: Kaohsiung (A. Henry s.n. fl. TAI).

PINGTUNG: Yenpu [Ako] (T. Soma A5, fl. and fr. TAIF–Syntype); Hengchun, Tashubo [Daizubo] (T. Hosokawa 3238, 15 Nov. 1931, fr. TAI); Hengchun, Maopitou (T. Hosokawa 3237 and s.n., 15 Nov. 1931, fr. TAI), (Chen and Kao, 3 Apr. 1956, fr. KYO, TAI), (S.F. Huang and H.C. Chen 4350, 2 Sep. 1988, fl. TUS), (Tateishi,

Nemoto and Hoshi 25220, 2 Nov. 1988, fl. and fr. TUS), near Maopitou, South Cape (Chen and Kao 4, 3 Apr. 1956, fr. TAI).

Distribution: Australia (northern New South Wales) north to S. China, southwestern Taiwan (Fig. 3), and east across several islands in the South Pacific.

Habitat: In open place at seaside or wasteland.

Glycine tomentella includes diploids ($2n=40$), eutetraploids ($2n=80$) and aneuploids at both diploid and tetraploid levels ($2n=38, 78$) (Newell and Hymowitz 1978). This species is genetically differentiated into various groups recognized by examination of isozyme variation (Grant et al. 1984; Doyle and Brown 1985) and 5S nuclear ribosomal gene repeat length variation (J.J. Doyle and Brown 1989). Reproductive isolations among these groups are evidenced by the analysis of the hybrid sterility (Putievsky and Broué 1979; Newell and Hymowitz 1983; Grant et al. 1984; Doyle et al. 1986; Singh et al. 1987). Two of six groups in tetraploid level (T2 and T4 groups) of *G. tomentella* are recognized in Taiwan (M. J. Doyle and Brown 1989). Morphological distinctions between both groups are, however, not studied by them. We can not deny the possibility that these two tetraploid groups are equivalent to *G. tomentella* and *G. dolichocarpa*. Relations these two tetraploid groups to *G. tomentella* or *G. dolichocarpa* need further examinations.

3) *Glycine tabacina* (Labill.) Benth., Fl. Austral. 2: 244 (1864). Hermann in U.S. Dept. Agric., Techn. Bull. no. 1218: 21, fig. 5 (1962). Chuang and Huang, Leg. Taiwan Pasture 56 (1966). Newell and Hymowitz in Amer. J. Bot. 65: 170, figs. 16–18 (1978); in Brittonia 32: 63 (1980), excl. var. *latifolia* Benth. Smith, Fl. Vit. Nova 3: 229 (1985). Huang and Huang in Taiwaniana 32: 64 (1987). Ohashi et al. in Sci. Rep. Tohoku Univ. 4th ser.

(Biol.) 40: 26 (1991).

Kennedya tabacina Labill., Sert. Aust.-Caled. 70, t. 70 (1824).

Leptolobium elongatum Benth. in Ann. Wien Mus. 2: 125 (1838).

Leptolobium tabacinum (Labill.) Benth. in Ann. Wien Mus. 2: 125 (1838).

Leptocytus elongatus Benth. in Trans. Linn. Soc. Lond., Bot. 18: 209 (1939).

Desmodium novo-hollandicum F. Muell. in Linnaea 25: 349 (1851).

Glycine pescadrensis Hayata, Icon. Pl. Formos. 9: 26 (1920). Sasaki, List Pl. Formos. 233 (1928); Cat. Govern. Herb. 276 (1930).

Glycine clandestina auct. non Wendl. (1798): Hosokawa in Trans. Nat. Hist. Soc. Formosa 25: 18 (1935); in Masamune, Short Fl. Formosa 100 (1936). Hermann, l. c. 13 (1962), pro parte. Hatusima and Amano, Fl. Okinawa rev. ed. 50 (1967). Hatusima, Fl. Ryuk. 323 (1971). Walker, Fl. Okinawa 583 (1976). Huang and Ohashi in Fl. Taiwan 3: 294 (1977). Ohashi in Wild Fl. Jap., Herb. Pl. 2: 211 (1982).

Chinese name: 澎湖大豆. Japanese name: ボウコツルマメ (Hatusima and Amano 1967).

A twining or prostrate perennial herb. Stems terete, 0.3–1 mm in diameter, sparsely clothed with retrorsely appressed short hairs (0.3–0.6 mm long). Leaves pinnately trifoliolate, dimorphous. Stipules triangulare-ovate, 1–2 mm long, striate, sparsely clothed with short hairs. Petioles 1–6 cm long, very sparsely clothed with retrorsely appressed short hairs (up to 0.4 mm long); pulvini 1–2 mm long, glabrous. Terminal petiolule distinct but short, 0.5–2 mm long, sparsely clothed with upwardly appressed or ascending short hairs; stipels linear to lanceolate, about 1 mm long, sparsely pubescent; secondary pulvini 1–1.5 mm long, rather densely clothed with spreading short hairs. Leaflets chartaceous, ciliate, glabrous

or sparsely clothed with appressed hairs (0.3–1 mm long) on both sides, veins prominent below. Terminal leaflets 0.5–6.5 cm long, 0.3–1.2 cm wide, ones in the leaves at lower nodes obovate or elliptic (2:5–2:3), obtuse or rounded and more or less mucronulate at the apex, obtuse at the base; ones in the leaves at higher nodes oblong to linear, or lanceolate (1:7–1:3), obtuse or acute at the apex, obtuse or rounded at the base. Lateral leaflets 0.5–3 cm long, 0.3–1.2 cm wide, slightly inaequilateral, obovate or elliptic (2:5–2:3) in the leaves at lower nodes, elliptic to linear or lanceolate (1:6–1:3) in ones at higher nodes, apex and base as in the terminal leaflets.

Racemes axillary, usually 2 times as long as the petioles or more, with 5–10 chasmogamous flowers; rachis 1–3 cm long, sparsely clothed with deflexed short hairs (0.2–0.5 mm long); peduncle 1–5 cm long, pubescent as the rachis. Bracts shorter than or as long as the pedicel, 1–1.5 mm long, lanceolate, sparsely pubescent. Chasmogamous flowers (Fig. 4A) 7–8 mm long. Pedicels 1–1.5 mm long, sparsely clothed with deflexed short hairs. Bracteoles 1–1.5 mm long, subulate to lanceolate, sparsely pilose. Calyx campanulate, sparsely clothed with appressed short hairs (up to 0.5 mm long) outside, glabrous inside, 4–4.5 mm long; tube 2–2.5 mm long; upper two lobes united to near the apices, 1.5–2 mm long; lower lobe triangular to narrowly triangular, about 2 mm long. Corolla reddish purple to pink. Standard 8–9 mm long including 1.5–2 mm long claw, about 8 mm wide, the lamina orbicular, emarginate at the apex. Wings 7.5–8 mm long including 2.5–3 mm long claw, 3–4 mm wide, the laminae inaequilaterally obovate. Keel-petals distinctly shorter than the wings, 5.5–6 mm long including 2.5–3 mm long claw, about 2 mm wide, the laminae inaequilaterally elliptic, adnate each other along their lower margins. Stamens diadel-

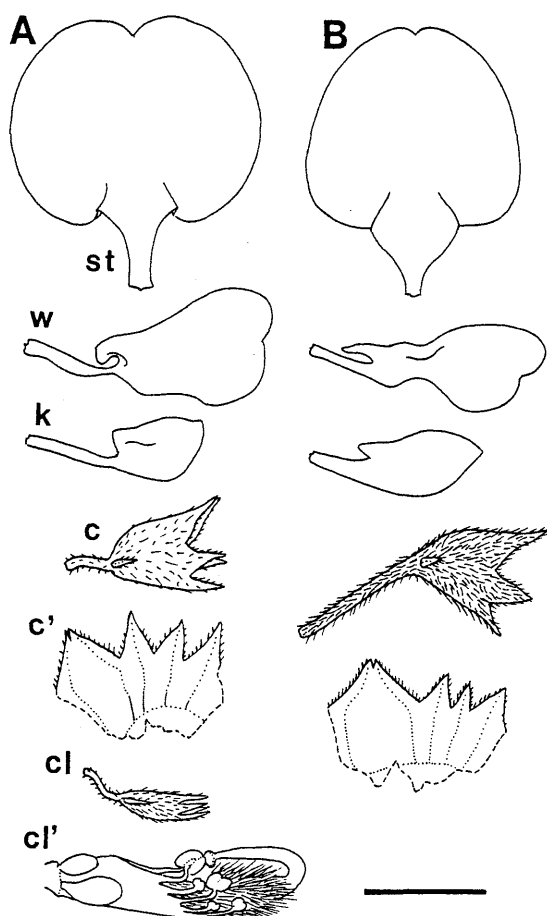


Fig. 4. Flowers of *Glycine tabacina* (A) and *G. clandestina* (B). st: Standard. w: Wing. k: Keel-petal. c: Calyx, c': Calyx dissected showing inside. cl: Cleistogamous flower. cl': Cleistogamous flower dissected showing recurved pistil and undeveloped petals and stamens. A from Taiwan, Penghu (Tateishi and Kajita 24717, TUS). B from Australia, South Australia (Carrick 3568, TI). Scale bar indicates 1 mm for cl', 4 mm for the others.

phous, filaments of 9 stamens joined into a column, vexillary stamen sometimes adnate partly to the column. Ovary subsessile or shortly stipitate, linear, sparsely to densely clothed with long appressed hairs, about 3 mm long, with (3–)6–9 ovules; style glabrous; stigma terminal, capitate.

Cleistogamous flowers (Fig. 4A: cl and cl') solitary or in few-flowered fascicles at the axils; calyx tubulate, 2.5–3 mm long, rather densely

clothed with short appressed hairs, the tube slender, the lobes subulate, shorter than the tube.

Legumes linear, flattened, straight, brown when matured, sparsely clothed with short appressed hairs, dehiscing spirally into two valves. Chasmogamous legumes (18–)22–30(–40) mm long, 3.5–4 mm wide, with (3–)5–8(–9) seeds. Cleistogamous legumes indistinguishable from the chasmogamous ones in shape except the slenderness of the calyx. Seeds dark brown or black, quadrate or ellipsoidal, 2–2.5 mm long, 1.8–2.2 mm wide, 1.2–1.6 mm thick; inner layers of endocarp covering over the seeds, thin, coarsely reticulate; hilum elliptic, the aril distinct, rather thick, the hilar tongue large, flap-like, overhanging the hilum.

Specimens examined. TAIWAN. PENGHU: No precise locality (T. Kawakami, May 1909, fl. and fr. TI–Holotype of *G. pescadrensis* Hayata, TAIF–Isotype), (C.E. Chang 15435, 15 Jan. 1980, fr. TUS); Tanbien (S.F. Huang 1995, 10 Feb. 1984, fr. TUS). Isl. Yuweng-tao, Hsiao-men–Chuwan (Tateishi and Kajita 24727, 22 Oct. 1988, fl. and fr. TUS). Isl. Paisha-tao, Houliiao (Jeng, 27 Aug. 1933, fl. TAI); Watung (Tateishi and Kajita 24717, 22 Oct. 1988, fr. TUS). Isl. Penghu-tao, Fengkuei (C.F. Hsieh 1095, 25 Jul. 1972, fl. TAI), *ibid.* (C.C. Hsu 1158, 8 Jul. 1972, fl. TAI); Makung (Y. Horikawa, Aug. 1929, fl. and fr. TAI), near Air Port (Tateishi and Kajita 24738, 22 Oct. 1988, fl. and fr. TUS). Isl. Wangan-tao, Wangan (Hung P0001, Jun. 1972 fl. TAI). Isl. Chimei (H.T. Yio K159, 20–30 Jul. 1985, fl. TUS), (S.F. Huang C003, 2 Feb. 1984, fr. TUS).

CULTIVATED. Original seeds collected in Penghu (C.E. Chang 15435) and sown in the greenhouse of Tohoku Univ., Sendai, Japan (T.T. Chen, 3 May 1986, fr. TUS), (T.T. Chen, 20 May 1986 fr. TUS).

Distribution: The Ryukyus, Taiwan (Isls.

Penghu) (Fig. 3), S. China, Micronesia, Australia, New Caledonia, the New Hebrides, Fiji, and Tonga.

Habitat: In open grassy place near seaside.

The earlier records of *Glycine tabacina* in Taiwan were based on Henry (1896) who collected it from the southern part. Hayata (1917, 1920) used this name to plants in southeastern and northern Taiwan, and, on the contrary, to the southern plants he (1920) gave a new name, *G. tomentella*. Chuang and C. Huang (1966) changed application of the name, *G. tabacina*, to the endemic plant in Penghu Islands, west of Taiwan. This species was named for the first time *G. pescadrensis* Hayata (1920) and then referred to *G. clandestina* by Hosokawa (1935). In their numerical studies on the subgenus *Glycine* based on the morphological and cytological characters, Newell and Hymowitz (1978) referred the plant from Taiwan to *G. tabacina*, taking notice of its intermediacy between *G. tabacina* and *G. clandestina*. The taxonomic treatments on *G. tabacina* and *G. clandestina* have been confused not only in Taiwan but also in Australia. Recently both species were recircumscribed by Tindale (1987b). According to her delimitation, the plant of Penghu is referable to *G. tabacina*.

Although Newell and Hymowitz (1978) stated Taiwanese *G. tabacina* has almost digitate leaves, our specimens from Penghu islands have pinnately trifoliolate leaves with short but distinct terminal petiolule and stipels at the top. They have 3–7(–9)-seeded legumes of (18–)22–30(–32) mm length. The endocarp remnant covering over the seed coat forms obscure reticulate network. By these characteristics, the plants are referable to *G. tabacina*, but not to *G. clandestina* which has digitately trifoliolate leaves without stipel in the median petiolules, 9–12-seeded legumes and seeds covered by an endocarp remnant with a distinct

reticulate network. In addition to these characteristics, the Penghu plants are distinct from *G. clandestina* in having shortly pedicellate flowers with shortly clawed petals (Fig. 4).

Glycine tabacina includes both diploids ($2n=40$) that are confined to eastern Australia and tetraploids ($2n=80$) that occur sympatrically with the diploids as well as on islands of the South Pacific and western central Pacific (Newell and Hymowitz 1978, Doyle et al. 1990c). The tetraploids have been shown to be distinguished into a minimum of two morphological and crossing groups. The plants belonging the first group are characteristic morphologically in having strongly dimorphic leaflets. Their leaflets are ovate or orbicular on the lower part of the plant, but are oblong to linear or lanceolate on the upper part of twining stems. The second group has stoloniferous habit and much less dimorphic leaflets. All the leaves from the lower portion to the upper are with ovate-lanceolate leaflets. The stems scramble at ground level, are less likely to twin, and are strongly stoloniferous, forming adventitious roots at the axils (Costanza and Hymowitz 1987; Singh et al. 1987; Doyle et al. 1990c). This grouping is supported by chloroplast DNA restriction map (Doyle et al. 1990a, 1990c) and nuclear ribosomal gene repeat phenotype (Doyle and Beachy 1985). The first group is assigned to A plastome group of three major plastome groups divided based on chloroplast DNA variation within subgenus *Glycine*, and the second to B plastome group (Doyle et al. 1990a, 1990c). Three accessions from Taiwan examined by them are included in A plastome group. This result coincides with the morphology of Taiwanese plant which belongs to the first group. We suppose the first group will be separated specifically from the second one. However, further extensive studies on this polymorphic species are necessary based on ample

material from Taiwan and other regions.

4) *Glycine max* (L.) Merr., Interpret. Rumph. Herb. Amb. 274 (1917).

4-1. Subsp. **max**. Ohashi in J. Jpn. Bot. **57**: 30 (1982).

Glycine max (L.) Merr.: Sasaki, List Pl. Formosa 233 (1928); Cat. Gavern. Herb. Formosa 276 (1930). Hermann in U.S. Dept. Agr., Tech. Bull. no. **1268**: 39 (1962). Ohashi in Fl. E. Himal. **1**: 157 (1966); in Enum. Flow. Pl. Nepal 121 (1979). Chuang and Huang, Leg. Taiwan Pasture 55, fig. 78 (1966). Verdcourt in Kew Bull. **24**: 256 (1972); Man. New Gun. Leg. 492 (1979). Huang and Ohashi in Fl. Taiwan **3**: 294, pl. 593 (1977). Hymowitz and Newell in Adv. Leg. Sci. 253 (1980). Lackey in Adv. Leg. Syst. **1**: 318 (1981). Shanmugasundaram and Sumarno in Maesen and Somaatmadja, Pl. Res. S.-E. Asia no. **1**: 43 (1989). Smartt, Grain Legumes 247 (1990).

Phaseolus Max L., Sp. Pl. 725 (1753).

Glycine hispida (Moench) Maxim. in Bull. Acad. Imp. Sci. St.-Petersb. **18**: 398 (1873). Forbes and Hemsley in J. Linn. Soc. Bot. **23**: 188 (1887). Henry, List 34 (1896). Matsum. in Ito and Matsum., Tent. Fl. Lutchu. 420 (1899). Matsum. and Hayata, Enum. Pl. Formos. 109 (1906). Kawakami, List Pl. Formosa 29 (1910). Hayata, Icon. Pl. Formos. **1**: 196 (1911).

Chinese name: 大豆. Japanese name: ダイズ.

Specimens examined. TAIWAN. CHANG-HUA: Tienchung, escaped along roadside (S.F. Huang 1993, 16 Apr. 1984, fl. TUS).

Cultivated as a pulse in the world.

4-2) Subsp. **formosana** (Hosokawa) Tateishi et Ohashi, comb. nov.

Glycine formosana Hosokawa in J. Soc. Trop. Agr. **4**: 308 (1932); in Masamune, Short Fl. Formosa 100 (1936).

Glycine tomentosa auct. non L. (1753), nec (Benth.) Benth. (1864): Matsum. in Ito and Matsum., Tent. Fl. Lutchu. 420 (1899). Matsum. and Hayata, Enum. Pl. Formos. 109 (1906). Kawakami, List Pl. Formosa 29 (1910). Hayata, Icon. Pl. Formos. **1**: 196 (1911); **6** (suppl.): 20 (1917). Sasaki, List Pl. Formosa 233 (1928).

Glycine tabacina auct. non (Labill.) Benth. (1864): Hayata, Icon. Pl. Formos. **9**: 29 (1920), p. p.

Glycine ussuriensis auct. non Regel et Maack (1861): Hermann in U.S. Dept. Agric., Tech. Bull. no. **1268**: 37 (1962), p. p., incl. syn. cit. *G. formosana*. Chuang and Huang, Leg. Taiwan Pasture 57 (1966).

Glycine soja auct. non Sieb. et Zucc. (1845): Huang and Ohashi, Fl. Taiwan **3**: 394, pl. 594 (1977).

Glycine max subsp. *soja* auct. non (Sieb. et Zucc.) Ohashi (1982): Ohashi et al. in Sci. Rep. Tohoku Univ. 4th ser. (Biol.) **38**: 315 (1984). Huang and Huang in Taiwania **32**: 64 (1987).

Chinese name: 台湾大豆. Japanese name: ホソバツルマメ (Hosokawa 1936).

A twining annual herb. Stems terete, 0.5–2 mm in diameter, rather densely to densely clothed with retrorsely appressed short white to yellow hairs and deflexed or spreading long white to yellow hairs (up to 1.2 mm long). Leaves pinnately trifoliate. Stipules triangular-ovate, 3–4 mm long, about 1 mm wide, acute to acuminate at the apex, striate, densely clothed with long spreading hairs. Petioles 1–6 cm long, hairy as in the stem; pulvini 2–3 mm long, hairy as in the stem. Terminal petiolule 2–9 mm long, rather densely to sparsely clothed with deflexed hairs and ascending ones; stipels subulate to lanceolate, 1–3 mm long, densely clothed with spreading long hairs; secondary pulvini 1–2.5 mm long, densely clothed with spreading long hairs. Leaflets (Fig. 5A–C) chartaceous, rather densely clothed with spreading

white to yellowish hairs (0.2–1 mm long) on both sides. Terminal leaflet linear to lanceolate (1:10–2:7), 2–8 cm long, 0.3–2 cm wide, obtuse or acute and more or less mucronulate at the apex, obtuse at the base. Lateral leaflets slightly inaequilateral, linear to lanceolate (1:10–2:5), 1.5–6.5 cm long, 0.3–2 cm wide, obtuse or acute at the apex, obtuse or rounded at the base.

Racemes axillary, distinctly shorter than the petioles, with 5–12(–15) chasmogamous flowers, subsessile or shortly pedunculate, the peduncles up to 5 mm long, densely clothed with deflexed long white to yellow hairs (0.2–1 mm long); rhachis 0.5–1.5 cm long, densely clothed with ascending long white to yellow hairs (0.2–1 mm long), but the lower portion with deflexed hairs and continuing to the pubescence of the peduncle. Bracts distinctly shorter than the pedicel, 1–1.5 mm

long, lanceolate, densely pilose, caducous. Chasmogamous flowers (Fig. 6A) about 5 mm long. Pedicels 1.5–3 mm long, sparsely to densely clothed with deflexed or spreading long hairs. Bracteoles 1–1.5 mm long, subulate to lanceolate, 1.5–2 mm long; lower lobe lanceolate, 1.5–2 mm long. Standard purplish, with dark purple lines near the center inside, 5–5.5 mm long including about 1.5 mm long claw, 4–4.5 mm wide, the lamina orbicular, emarginate at the apex. Wings white, 4.5–5 mm long including 1.5 mm long claw, 1–1.5 mm wide, the laminae narrowly obovate, auriculate at the base. Keel-petals purple in upper part, distinctly shorter than the wings, about 3.5 mm long including about 1.5 mm long claw, about 1 mm wide, the laminae oblong, adnate each other along their lower margin. Stamens diadelphous, filaments of 9 stamens

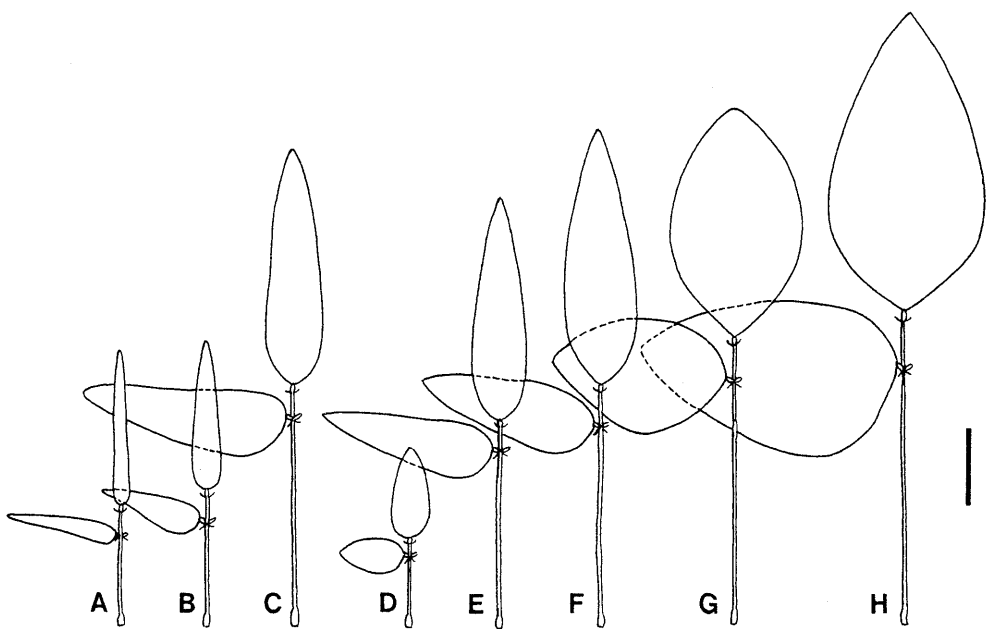


Fig. 5. Variation of shape of leaflets in *Glycine max* subsp. *formosana* (A–C) and subsp. *soja* (D–H). A from Taiwan, Hsinchu (Honda 118, TI); B from Taiwan, Hsinchu (Shimada 4493, TAI–Holotype of *G. formosana*); C from Taiwan, Miaoli (Honda 59, TI). D from Japan, Yamanashi-ken (Tateishi 222, TUS); E from Japan, Yamaguchi-ken (Imada 4893, TUS); F–G from Japan, Nagasaki-ken, Isls. Goto (F: Tateishi and Hoshi 8773, TUS; G: Tateishi 4633, TUS); H from Japan, Miyagi-ken (Iketsu 137e, TUS). Scale bar indicates 2 cm.

joined into a column, vexillary stamen sometimes adnate partly to the column. Ovary sessile, linear, sparsely to densely clothed with long appressed hairs, about 1.5 mm long, with (1-)2-3(-4) ovules; style glabrous; stigma terminal, capitate.

Cleistogamous flowers produced occasionally at the axils, solitary or in few-flowered fascicles, often with variously reduced petals; calyx narrowly

campanulate, about 2 mm long, densely clothed with long ascending hairs, the lobes almost as long as the tube.

Legumes (Fig. 7A: p) linear, straight, slightly constricted between the seeds, brown when matured, densely clothed with long spreading hairs, dehiscing spirally into two valves. Chasmogamous legumes (9-)14-20(-22) mm long, 3.5-5 mm

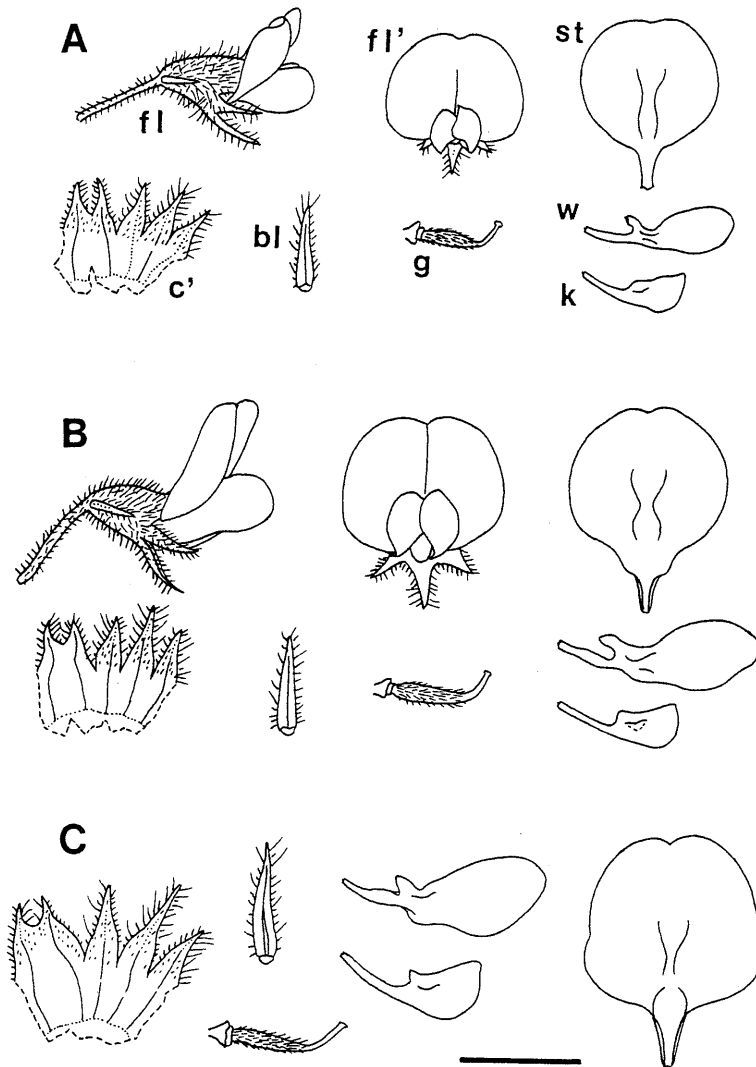


Fig. 6. Flowers of *Glycine max* subsp. *formosana* (A), subsp. *soja* (B), and subsp. *max* (C). fl: Flower. fl': Flower in front view. bl: Bracteole. c': Calyx dissected showing inside. st: Standard. w: Wing. k: Keel-petal. g: Pistil. A from Taiwan, Nantou (cult. at Tohoku Univ.) (Tateishi 11031, TUS). B from Japan, Miyagi-ken (Tateishi in 1990, TUS). C from China, Hainan, cultivated (Tuyama et al. 81600, TUS). Scale bar indicates 2 mm for bl, and 4 mm for the others.

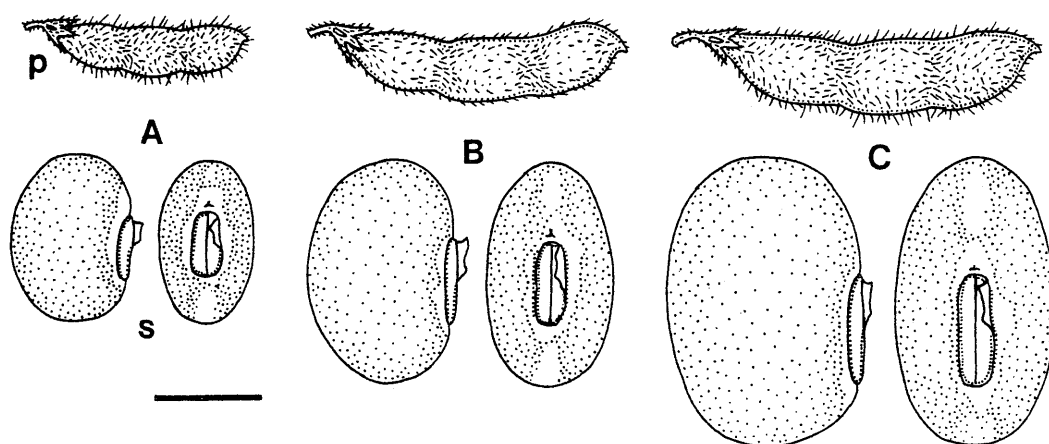


Fig. 7. Legumes and seeds of *Glycine max* subsp. *formosana* (A) and subsp. *soja* (B–C). p: Legumes. s: Seeds. A from Taiwan, Nantou (Ohashi et al. 12317, TUS). B from Japan, Tokyo (Tateishi 15540, TUS). C from Japan, Miyagi-ken (Tateishi 15532, TUS). Scale bar indicates 1 cm for legumes, and 1 mm for seeds.

wide, (1–)2–3-seeded. Cleistogamous legumes indistinguishable from the chasmogamous ones. Seeds (Fig. 7A: s) dark brown or black, ellipsoidal, 2.3–4 mm long, 1.8–2.5 mm wide, 1.2–2.2 mm thick; inner layers of endocarp remaining and covering over the seed coat, thin, fine-reticulate; hilum oblong, the aril quite thin, the hilar tongue small, membranaceous, small.

Specimens examined. TAIWAN. TAIPEI: Tanshui [Tamsui] (Faurie 1106, Sep.–Oct. 1914, fr. KYO).

TAOYUAN: Tachi (Y. Shimada 1344, Sep. 1924, fl. TAI), alt. 0–20 m (S. F. Huang, 19 Apr. 1984, TUS).

HSINCHU: Chutou, Yulou (Y. Shimada 4493, 22 Sep. 1928, fr. TAI—Holotype of *G. formosana*; KYO—Isotype), (M.T. Kao, 8 Apr. 1956, fr.; 25 Dec. 1956, fr.; 8749, 28 Sep. 1974, fr. TAI); Chuton (M.T. Kao 10127, 13 Sep. 1985, fl. TUS).

MIAOLI: No precise locality (Honda 59, fl. TI), (Honda 118, fl. TI).

NANTOU: Wushe, alt. 1100–1150 m (Ohashi et al. 12317, 17 Oct. 1982, fr. TUS).

KAOSHIUNG: Chishan, Shanping (S. Okamoto, 6 Mar. 1942, fl. KYO); Kuanshan Pass

(S. Okamoto, 5 Oct. 1937, fr. KYO).

CULTIVATED: Original seeds coll. at Wushe (Ohashi et al. 12317) and sown in the greenhouse of Tohoku Univ., Sendai, Japan (Tateishi 11031, 21 Sep. 1985, fl. TUS).

Distribution: Northern part and central mountains of Taiwan (Fig. 3). Subsp. *soja* is distributed from Ussuri and Amur through Korea to China and Japan.

This plant has recently been referred to *Glycine soja* or *G. max* subsp. *soja*, which has been assumed to be the original plant of soybean, *G. max*. Taiwanese plants, however, are distinct in having quite narrower leaflets (Fig. 5A–C) and villose legumes with long patent hairs (Fig. 7A). Comparing to these characters with those of Japanese plants of *G. max* subsp. *soja*, the Taiwanese plant occupies the extreme position not entirely discontinuous but slightly continuous within a wide range of variation of subsp. *soja* (Figs. 5, 7). In addition to these characters, flower, legume and seed of the Taiwanese plant are distinctly smaller than those of subsp. *soja* (Figs. 6, 7; Tabs. 4, 5). Based on these morphological distinctions and disjunctive distribution we con-

Table 4. Size and weight of seeds of *Glycine max* subsp. *formosana* and subsp. *soja**

Acc. no	Locality** (Latitude)	Specimens examined or voucher specimens	Sample no	Length(l) mean \pm SD(mm)	Width(w) mean \pm SD(mm)	Thickness(t) mean \pm SD(mm)	Vol. (π lwt/6) mean \pm SD(mm ³)	100 seeds weight(g)
subsp. <i>formosana</i>								
F01	TAI. Nantou (24° 02')	Ohashi et al. 12317	50	2.92 \pm 0.12	2.08 \pm 0.11	1.71 \pm 0.09	5.46 \pm 0.67	0.73
F01	do (cult. at TUS)	Tateishi 11031	78	3.11 \pm 0.34	2.11 \pm 0.17	1.71 \pm 0.22	6.02 \pm 1.72	0.88
subsp. <i>soja</i>								
S01	JAP. Tokyo (35° 44')	Fukuda, 16 Nov. 1965	51	4.07 \pm 0.20	2.59 \pm 0.15	2.34 \pm 0.15	12.98 \pm 1.80	1.77
S02	JAP. Tokyo (35° 42')	Tateishi 15540	95	4.03 \pm 0.23	2.77 \pm 0.19	2.37 \pm 0.20	13.99 \pm 2.45	1.94
S03	KOR. Seoul (37° 33')	Uchiyama, 12 Dec. 1900	50	4.23 \pm 0.20	2.90 \pm 0.14	2.19 \pm 0.18	14.16 \pm 1.94	1.72
S04	JAP. Ibaraki (36° 45')	Takahashi and Chen, 1980	13	4.26 \pm 0.20	3.02 \pm 0.19	2.26 \pm 0.24	15.39 \pm 3.04	
S05	JAP. Fukuoka (33° 31')	Ohashi and Tateishi 950	32	4.14 \pm 0.19	3.02 \pm 0.18	2.44 \pm 0.18	16.05 \pm 2.46	
S06	JAP. Miyagi (38° 12')	Naohara, 11 Oct. 1931	39	4.57 \pm 0.38	3.05 \pm 0.17	2.23 \pm 0.21	16.41 \pm 2.94	
S07	JAP. Shiga (35° 04')		50	4.13 \pm 0.21	3.11 \pm 0.18	2.42 \pm 0.21	16.43 \pm 2.83	2.17
S08	JAP. Niigata (37° 10')	Kurosaki 11463	31	4.83 \pm 0.32	3.31 \pm 0.18	2.37 \pm 0.15	19.93 \pm 2.91	
S09	JAP. Miyagi (38° 14')	Takahashi et al. 134	51	4.61 \pm 0.26	3.43 \pm 0.18	2.78 \pm 0.18	23.20 \pm 3.29	
S12	JAP. Miyagi (38° 16')	Tateishi 15532	50	5.21 \pm 0.35	3.39 \pm 0.23	2.97 \pm 0.25	27.75 \pm 5.35	3.76

* All the specimens measured are preserved in TUS.

** JAP: Japan; KOR: Korea; TAI: Taiwan.

Table 5. Variations of legume length and seed number in *Glycine max* subsp. *formosana* and subsp. *soja*

Acc. no	Locality*	Sample no	Seed/legume mean \pm SD	Percent (%) and length (mean \pm SD mm) of legumes with							Total mean \pm SD(mm)	range(mm)
				1 seed	2 seeds	3 seeds	4 seeds					
subsp. <i>formosana</i>												
F01	(Cult. at TUS)	50	2.7 \pm 0.6	6.0	9.7 \pm 0.5	22.0	15.6 \pm 1.9	72.0	18.8 \pm 1.9	0	17.5 \pm 3.0	9.0–21.5
subsp. <i>soja</i>												
S01	JAP. Tokyo	17	2.5 \pm 0.7	11.8	12.5 \pm 1.5	29.4	21.8 \pm 0.2	58.8	24.0 \pm 1.2	0	22.0 \pm 3.7	11.0–26.5
S02	JAP. Tokyo	126	3.0 \pm 0.5	1.6	16.0 \pm 0.5	7.9	20.5 \pm 0.7	82.5	24.6 \pm 1.3	7.9	24.5 \pm 2.4	22.1–26.8
S04	JAP. Ibaraki	16	2.8 \pm 0.4	0	—	25.0	22.3 \pm 2.0	75.0	25.0 \pm 0.7	0	24.3 \pm 1.7	20.0–26.0
S09	JAP. Miyagi	57	3.0 \pm 0.7	0	—	21.1	22.5 \pm 1.4	54.4	27.1 \pm 1.1	24.5	27.2 \pm 3.2	20.5–33.5
S12	JAP. Miyagi	81	2.6 \pm 0.6	3.7	20.0 \pm 1.1	32.1	26.1 \pm 2.4	64.2	31.8 \pm 1.1	0	29.6 \pm 3.6	19.0–34.0

*See Table 4 for detail of the localities and the voucher specimens.

sider, therefore, Taiwanese plant as a subspecies of *Glycine max*, i.e. subsp. *formosana*.

We wish to express our thanks to the curators of the herbaria of KYO, TAI, TAIF and TI, who enabled us to examine the specimens of the Taiwanese *Glycine*. This study was supported by the Grant-in-Aid for Overseas Scientific Survey from the Ministry of Education, Science and Culture of Japan (No. 63041016 in 1988).

References

- Chuang C. C. and Huang C. 1966. *Glycine*. In The Leguminosae of Taiwan for pasture and soil improvement, pp. 54–57, figs. 77–80.
- Costanza S. H. and Hymowitz T. 1987. Adventitious roots in *Glycine* subg. *Glycine* (Leguminosae): Morphological and taxonomic indicators of the B genome. *Pl. Syst. Evol.* **158**: 37–46.
- Doyle J. J. and Beachy R. N. 1985. Ribosomal gene variation in soybean (*Glycine*) and its relatives. *Theor. App. Genet.* **70**: 369–376.
- and Brown A. H. D. 1989. 5S nuclear ribosomal gene variation in the *Glycine tomentella* polyploid complex (Leguminosae). *Syst. Bot.* **14** (3): 398–407.
- , Doyle J. L. and Brown A. H. D. 1990a. A chloroplast-DNA phylogeny of the wild perennial relatives of soybean (*Glycine* subgenus *Glycine*): Congruence with morphological and crossing groups. *Evolution* **44** (2): 371–389.
- , ———, Brown A. H. D. and Grace J. P. 1990b. Multiple origins of polyploids in the *Glycine tabacina* complex inferred from chloroplast DNA polymorphism. *Proc. Natl. Acad. Sci. USA* **87**: 714–717.
- , ———, Grace J. P. and Brown A. H. D. 1990c. Reproductively isolated polyploid races of *Glycine tabacina* (Leguminosae) had different chloroplast genome donors. *Syst. Bot.* **15** (2): 173–181.
- Doyle M. J. and Brown A. H. D. 1985. Numerical analysis of isozyme variation in *Glycine tomentella*. *Biochem. Syst. Ecol.* **13** (4): 413–419.
- , Grant J. E. and Brown A. H. D. 1986. Reproductive isolation between isozyme groups of *Glycine tomentella* (Leguminosae), and spontaneous doubling in their hybrids. *Aust. J. Bot.* **34**: 523–535.
- Forbes F. B. and Hemsley W. B. 1887. *Glycine*. In Enumeration of all the plants known from China proper, Formosa, Hainan, the Corea, the Luchu Archipelago, and the Island of Hongkong, together with their distribution and synonymy. *J. Linn. Soc. Bot.* **23**: 188–189.
- Grant J. E., Brown A. H. and Grace J. P. 1984. Cytological and isozyme diversity in *Glycine tomentella* Hayata (Leguminosae). *Aust. J. Bot.* **32**: 665–677.
- Hatusima S. and Amano T. 1967. *Glycine*. In Flora of Okinawa, p. 50. Okinawa Association of Biology Education, Naha.
- Hayata B. 1911. *Glycine*. In *Icones Plantarum Formosanarum* **1**: 195–196.
- 1917. *Glycine*. In *Icones Plantarum Formosanarum* **6** (suppl.): 20.
- 1920. *Glycine*. In *Icones Plantarum Formosanarum* **9**: 26–30.
- Henry A. 1896. *Glycine*. In A list of plants from Formosa. *Trans. Asiatic Soc. Jap.* **24** (suppl.): 34.
- Hermann F. J. 1962. A revision of the genus *Glycine* and its immediate allies. U.S. Dept. Agric., Techn. Bull. no. **1268**, 1–82.
- Hosokawa T. 1932. *Notulae Leguminosarum ex Asiae Orientale II*. *J. Soc. Trop. Agric.* **4**: 308–316.
- 1935. Materials of the botanical research towards the flora of Micronesia III. *Trans. Nat. Hist. Soc. Formosa* **25**: 17–39.
- 1936. *Glycine*. In Masamune G., Short Fl. Formosa, p. 100.
- Huang S. F. and Huang T. C. 1987. *Glycine*. In: Taxonomic treatment of the Papilionoideae (Leguminosae) of Taiwan. *Taiwania* **32**: 63–65.
- Huang T. C. and Ohashi H. 1977. *Glycine*. In Flora of Taiwan **3**: 293–298.
- Hymowitz T. and Newell C. A. 1981. Taxonomy of the genus *Glycine*, domestication and use of soybeans. *Econ. Bot.* **35**: 272–288.
- Kawakami T. 1910. *Glycine*. In A list of plants of Formosa, p. 29. Government of Formosa, Taihoku (in Japanese).
- Makino T. and Nemoto K. 1925. *Glycine*. In Flora of Japan pp. 742–743. Nihonshokubutusunan-kankou-kai, Tokyo (in Japanese).
- and ——— 1931. *Glycine*. In Flora of Japan, ed. rev. enl. pp. 588–589. Shunyodo, Tokyo (in Japanese).
- Matsumura J. 1899. *Glycine*. In Ito and Matsumura, Tentamen Florae Lutchuensis, p. 420.
- and Hayata B. 1906. *Glycine*. In *Enumeratio Plantarum Formosarum*, p. 109.
- Newell C. A. and Hymowitz T. 1978. A reappraisal of the subgenus *Glycine*. *Amer. J. Bot.* **65**: 168–179.
- and ——— 1980. A taxonomic revision in the genus *Glycine* subgenus *Glycine* (Leguminosae). *Brittonia* **32**: 63–69.
- and ——— 1983. Hybridization in the genus *Glycine* subgenus *Glycine*. Willd. (Leguminosae, Papilionoideae). *Amer. J. Bot.* **70**(3): 334–348.
- Ohashi H., Tateishi Y., Huang T. C. and Chen T. T. 1984. Taxonomic studies on the Leguminosae of Taiwan I. *Sci. Rep. Tohoku Univ. 4th ser. (Biol.)* **38**: 277–334.
- , ———, Nemoto T. and Hoshi H. 1991. Taxonomic studies on the Leguminosae of Taiwan IV. *Sci. Rep. Tohoku Univ. 4th ser. (Biol.)* **40**:

- 1-37.
- Putievsky E. and Broué P. 1979. Cytogenetics of hybrids among perennial species of *Glycine* subgenus *Glycine*. *Aust. J. Bot.* **27**: 713-723.
- Sasaki S. 1928. *Glycine*. In *List of plants of Formosa* p. 233. The Natural History Society of Formosa, Taihoku (in Japanese).
- 1930. *Glycine*. In *A catalogue of the government herbarium*, p. 276. Government Research Institute, Taihoku, Formosa (in Japanese).
- Singh R. J., Kollipara K. P. and Hymowitz T. 1987. Polyploid complexes of *Glycine tabacina* (Labill.) Benth. and *G. tomentella* Hayata revealed by cytogenetic analysis. *Genome* **29**: 490-497.
- Tateishi Y. and Ohashi H. 1991. *Glycine*. In Ohashi et al. *Taxonomic studies on the Leguminosae of Taiwan IV*. *Sci. Rep. Tohoku Univ. 4th ser. (Biol.)* **40**: 23-26.
- Tindale M. D. 1984. Two new eastern Australian species of *Glycine* Willd. (Fabaceae). *Brunonia* **7**: 207-213.
- 1987a. A new North Queensland species of *Glycine* Willd. (Fabaceae). *Brunonia* **9**: 99-103.
- 1987b. Taxonomic notes on three Australian and Norfolk Island species of *Glycine* Willd. (Fabaceae: Phaseoleae) including the choice of a neotype for *G. clandestina* Wendl. *Brunonia* **9**: 179-191.
- and Craven, L. A. 1988. Three new species of *Glycine* (Fabaceae: Phaseoleae) from North-western Australia, with notes on amphicarpy in the genus. *Aust. Syst. Bot.* **1**: 399-410.

要 旨

ダイズ属はインゲンマメ連ダイズ亜連に属する小属で、最近オーストラリアから数種が記載され、また台湾から我々が1種を記載したので、今日では17種を数えるに至っている。このうち16種は多年草で、*Glycine* 亜属を構成する。この亜属はオーストラリアを中心に分布し、形態的、遺伝的に変異の著しい種が多い。一方、残りの1種は一年草の *G. max* でこの1種のみで *Soja* 亜属をつくる。この亜属は東アジア固有である。

我々は1982年以来続けている台湾マメ科植物調査のなかで、この属に注目してきた。台湾は *Glycine* 亜属の分布の北端にあたり、オーストラリアからミクロネシア、南中国に広がる *G. tabacina* や *G. tomentella* が分布する。他方で、*Soja* 亜属のツルマメ (*G. max* subsp. *soja*) が知られている。しかしこれら3種の台湾での変異は複雑で、このため分類学的取扱の混乱が著しい。これまでの研究の過程で、我々は台湾の南東部海岸及び北部に生育する *G. tomentella* としばしば混

同されている植物を新種 *G. dolichocarpa* として発表した (Tateishi and Ohashi 1991)。本論文は台湾のダイズ属の分類学的研究のこれまでの結果をまとめたものである。

1) 台湾には自生種として *G. dolichocarpa* ナガミツルマメ、*G. tomentella* ヒロハヤブマメ、*G. tabacina* ボウコツルマメ (以上 *Glycine* 亜属)、*G. max* subsp. *formosana* ホソバツルマメ (*Soja* 亜属) の4種が認められる。

2) これら4種を区別するための検索表および記載をつくった。

3) *G. dolichocarpa* は植物体に下向した長毛が密生し、小葉が披針形から卵形で、花はやや大きく、上萼歯は基部から $\frac{2}{3}$ まで癒合し、豆果は長く、(3-)5-9種子を含み、種子と種子の間でくびれることがなく、短毛が散生する。一方の *G. tomentella* は小葉が狭楕円形ないし楕円形あるいは倒卵形、植物体にはほぼ開出した長毛が密生し、花は小さく、上萼歯は中程まで癒合し、果実は短く、(1-)2-5種子を含み、種子と種子の間が多少ともくびれる。このように *G. dolichocarpa* は *G. tomentella* とは明らかに異なる種と考えられる。また、*G. tabacina* とは植物体の毛が密生すること、萼歯が萼筒より長く、上萼歯が先端付近までは癒合しないことなどで区別できる。

G. dolichocarpa には、この植物が *G. tabacina* に誤同定された際につけられたタバノマメ、また *G. tomentosa* に誤同定された際のケナガヤブマメという和名がすでにある。しかし、これらは誤って当てられた学名に伴ってつけられたものであり、混乱の元となる可能性がある。さらにこの種の特徴を表わしているわけでもない。そこで新たにナガミツルマメと命名する。一方、*G. tomentella* にはヒロハヤブマメという和名がある。

4) 澎湖島のボウコツルマメは最近 *G. tabacina* が当てられることが多くなったが、依然 *G. clandestina* とする意見もある。後者は葉が掌状3出葉で、中央の小葉(頂小葉)の基部には小托葉がなく、豆果は9-12種子を持ち、種子は明瞭な網目状の内果皮残余膜で覆われる等の特徴で *G. tabacina* から区別される (Tindale 1987 b)。一方、ボウコツルマメでは葉が羽状3出葉で短い

明瞭な頂小葉柄があり、そこに一對の小托葉をつけ、豆果は3-7(-9)種子を含み、種子を覆う内果皮残余膜は不明瞭な網目状である。これらは全て *G. tabacina* の特徴と一致する。さらに、小花梗が短く、花卉の柄が短いことも *G. clandestina* より *G. tabacina* の特徴である。

G. tabacina にはオーストラリアに固有の2倍体 ($2n=40$) とオーストラリアから太平洋諸島、東アジアまで広く分布する4倍体 ($2n=80$) が認められている (Newell and Hymowitz 1978; Doyle et al. 1990 c). このうち特に4倍体は少なくとも2つの形態的に異なる遺伝的にも隔離した群に分けられる。その第1群は葉が2形で、幼時の小葉は卵形あるいは円形だが、生長するに伴い他物に巻き付きながら伸びた茎の上部につける葉の小葉は線形ないし狭楕円形になる。他方、第2群では小葉は幼時からだいたい卵形から披針形で大きく変化せず、茎は地を這って走出枝状になり、地に接した節から不定根を出す (Costanza and Hymowitz 1987; Singh et al. 1987; Doyle et al. 1990 c). ボウコツルマメは第1群の特徴によく一致する。このグルーピングは葉緑体 DNA を用いた分子遺伝学的な研究等によっても支持されている (Doyle et al. 1990 a, c). それによれば第1群は *Glycine* 亜属の葉緑体 DNA の制限酵素多型変異に基づいて区別された3群のうち A plastome 群に、第2群は B plastome 群に含まれる。この研究で台湾産のボウコツルマメも調べら

れているが、全て A plastome 群で (Doyle et al. 1990 c), 形態的な特徴と一致した。我々はボウコツルマメの含まれる第1群は第2群から明らかに異なる別種と予想しているが、そう結論づけるためには台湾を含めた各地域からのさらに多くの資料に基づいた研究が必要である。

この第1群の植物の和名はもともと佐々木 (1928) によってボウコヤブマメとされた。しかし、初島・天野 (1967) がボウコツルマメとして以来、専らこちらが使われている。この種がヤブマメ属でないことも考慮して、現在一般に広く使われているボウコツルマメを使用するのがよいと思われる。

5) 台湾のツルマメは Hermann (1962) 以来日本や中国などのツルマメと同種と考えられてきたが、小葉が非常に細長く、莢に長毛が密生する点がかつて注目され、新種 *G. formosana* として記載されたこともある。今回、これらの形質の変異を調べたところ、台湾産植物の形質状態は日本産のツルマメの変異に連続してしまうものの、変異域の一端にあることが分かった。さらに、花が小さく莢や種子も日本産ツルマメのものよりは明らかに小さい。そこで、地理的分布の不連続性をも考慮し、台湾のものはツルマメの地理的な亜種とし、*G. max* subsp. *formosana* (Hosokawa) Tateishi et Ohashi として扱いたいと思う。和名はホソバツルマメがある。